Abstract submitted to the session E : Balance of plant

Optimization of a fuel cell system using energy integration techniques

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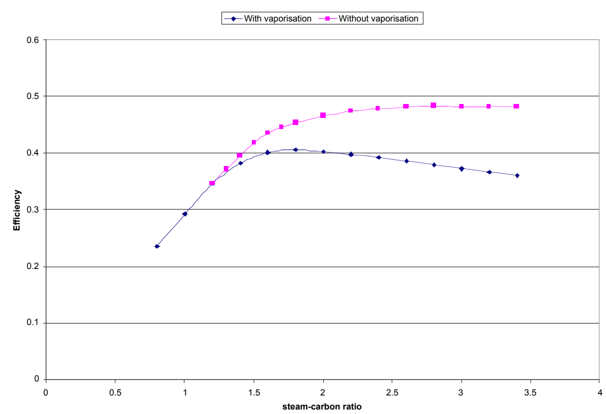
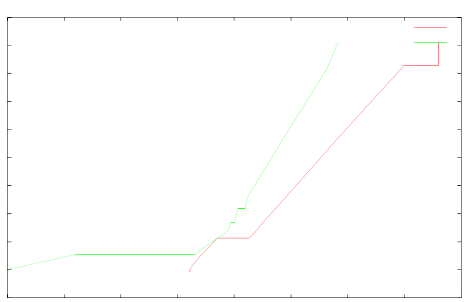
A system model including a PEM fuel cell and its fuel preparation process has been developed. The goal was to investigate the process configurations to identify the optimal operating conditions and the optimal process structure of the system by applying modelling and energy integration techniques.

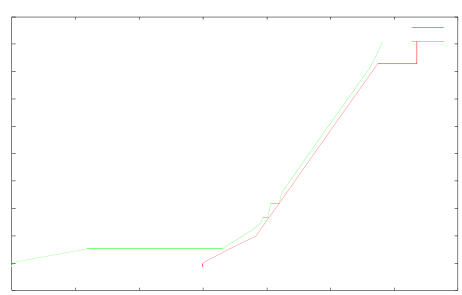
The Ballard&Alstom's system has been considered as the initial process structure in order to define the major equipments to be considered. A simulation model using a commercial chemical process simulation software (BELSIM-VALI) has been developed. The model includes a catalytic reforming, CO-removal (Shift) and preferential oxidation for the fuel processing as well as a PEM fuel cell model and the combustion chain. The equation solver approach used by this software tool offered a real flexibility for the process synthesis approach that has been applied. The energy and the material flows obtained by simulation have been used to compute the process composite curves of the system. This has been used to identify the best heat exchange opportunities and to define the optimal operating conditions of the reforming system that provide the best overall efficiency for the balance of plant.

The system has been studied according to the energy efficiency, the exergy efficiency as well as thermo-economical parameters in the context of the combined production of heat and power.

By improving the energy integration of the system, the efficiency can be raised from 35% for the reference system to 48%. To illustrate the results that will be presented, the following charts show, for a given reforming temperature, the influence of steam to carbon ratio on the system efficiency for two different configurations as well as the corresponding composite curves resulting for the balanced system.







Key words: Fuel cell systems, optimization, energy integration, process synthesis.